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The Biology of *Phorocera hamata* A. & W., a Tachinid Parasite of Sawflies[1]

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Introduction

During the course of investigations dealing with the biological control of insect pests of conifers, several species of sawflies were found to be heavily attacked by the tachinid parasite *Phorocera hamata* A. & W. The present paper describes the immature stages and includes the life-history of the parasite under laboratory conditions.

P. hamata was described by Aldrich and Webber (1924) and placed in the subgenus *Parasetigena* of Brauer and Bergenstamm. The specimens described by them were taken in the United States at New Haven, Conn., and Clemson, S.C. The species has been recorded from very few areas in North America. In Canada it has been recorded as occurring in New Brunswick by Reeks (1938) and in Quebec by Daviault (1943). In current studies the parasite was reared from sawfly collections made at Tweed, Chatterton, and Kemptville, Ont.

P. hamata has been recorded only as a parasite of sawflies. The specimens described by Aldrich and Webber were reared from *Diprion simile* Htg., and from an unidentified pupa found under bark. Reeks and Daviault record it from collections of the European spruce sawfly, *Gilpinia hercyniae* Htg. (=*Diprion polytomum* Htg.). In the present studies the species was found to be parasitic on *Neodiprion lecontei* Fitch, *N. banksianae* Rohw., and *N. nanulus* Schedl.

Field and laboratory studies indicate that there is but one generation a year. The emergence of adults from collections of *N. lecontei* was continuous throughout June and July, and the parasites were present in the field during the period from June to September, when the larvae of *N. lecontei* are normally found on the trees.

DESCRIPTION OF STAGES

The Adult

The adult is fully described by Aldrich and Webber (1924), with mention of its close relationship to *P. claripennis* Macq. A few of the minor differences are listed.

Reproductive Systems.—The reproductive system of the female varies very little from that of other tachinids depositing macrotype eggs. Each of the two ovaries (Fig. 15) consists of a large number of ovarioles containing a variable number of eggs. The lateral oviducts unite to form the common oviduct leading to the anterior end of the uterus. The spermathecal ducts connecting the three black, spherical spermathecae to the uterus enter ventrally. The median duct is larger than the lateral ducts. The openings of the accessory glands are situated laterally and directly behind the opening of the spermathecal ducts.

The male reproductive organs are of the usual tachinid type and are similar to those of *Aplomya caesar* (Ald.) as described by Wishart (1945). The paired testes (Fig. 16) are elongate, tapering, and heavily pigmented. The accessory glands and the bulb of the ejaculatory duct are comparatively small. The elongate

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ejaculatory duct enters the ejaculatory pump, which is situated anterior to the penis.

The Egg

The egg (Fig. 1) measures 0.3 mm. in width and 0.6 mm. in length. It is macrotype, white, and elongate-oval. The anterior end is slightly narrower than the posterior, both being equally rounded when viewed from above. The rigid, convex dorsal surface is covered with numerous small spines. Faint reticulations form a definite hexagonal pattern on the egg surface as shown in Fig. 1. Under high magnification a group of approximately twelve micropylar cells can be observed at either end on the dorsal surface of the egg. The undersurface is subchitinous, transparent, and not flattened. In cross section the egg is wedge-shaped (Fig. 2).

Larval Stages

First Stage.—The first-stage larva varies from 0.43 mm. in length and 0.1 mm. in width just after eclosion to 1.7 mm. in length and 0.8 mm. in width when fully fed. The semitransparent larva is moderately elongate, tapering anteriorly, and rounded posteriorly. The pseudocephalon is without spines, bearing scattered sensory pits and a pair of bulb-like sensory organs. The arrangement of the spines is shown in Table I and in Fig. 3. There is some variation in the spinal pattern from one side of an individual to the other as well as between different individuals of the same species. Spines on the anterior margins of the segments are directed posteriorly, whereas those on the posterior margins are directed anteriorly. Exceptions to this general condition have been observed. The greatest concentration of spines is found on the anteroventral portion of the

TABLE I.

THE APPROXIMATE NUMBER OF ROWS OF SPINES ON THE DORSAL, LATERAL AND VENTRAL REGIONS OF THE LARVAL SEGMENTS OF *P. hamata*

STAGE	BAND	POSITION	SEGMENTS											
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	
I	Anterior	Dorsal	5–6	5	3	3	4	4	3	3–4	3	2–3		DESCRIPTION IN TEXT
		Lateral	3–4	4–5	3	3	1–3	2	2	3	2	2		
		Ventral	7–8	7	5	4	3	4	4	3	4	3		
	Posterior	Dorsal	2*	2*	2*			1–3	2–3	2	2	2		
		Lateral	1*	2*				1–3	2	3	2–3	2		
		Ventral					1*	1–3	2	3	2–3	3		
II	Anterior	Dorsal	7–8	4–6	4	4	3	3	3–4			1–2		
		Lateral	5	4	4	4	3	3	2		2	1–2		
		Ventral	8–9	9–11	9	5–6	4	3	2	3	2	3		
	Posterior	Dorsal	2*	2*			2	3	3	3	5	5		
		Lateral					2	3	5	5	5	6		
		Ventral						2	3	4	4	5		
III	Anterior	Dorsal	6–8	7–9	6–7	3–4	2–4	2–3	3–4	3–4	3–4	3–4		
		Lateral	3–4	4–5	5	2–4	2–4	2–3	1–2	2–4	2–4	2–4		
		Ventral	8–10	10–12	10	2–4	2–4	1–2	2–3	2–4	2–4	2		
	Posterior	Dorsal	3*			1	1	1	1–2	2–3	2–4	2–3		
		Lateral							1–2	1–2	1–3	2		
		Ventral					1	1	2	1–3	2–3	2–3		

* Posteriorly directed spines.

body. A rather conspicuous, semicircular band of strong spines extends dorsolaterally above the stigmatal openings on segment XI. Between and below the stigmata on this segment is found a patch of strong spines. The apex of the segment bears two conspicuous sensory papillae, which are much longer than broad.

The first-stage larva is metapneustic, bearing two small stigmata on the posterior surface of the last abdominal segment slightly above the longitudinal axis (Fig. 3). The felt chambers are elongate and slightly pigmented. The buccopharyngeal armature (Fig. 4) is pigmented and unarticulated and may be divided into anterior, intermediate, and basal regions. The anterior region, consisting of a median hook directed slightly downward, bears on its upper edge 10 moderately prominent teeth (Fig. 5). By the end of the first stage the teeth appear less prominent (Fig. 6) and are often difficult to locate. In the anterior region of the mouth hook is a pair of lightly-pigmented lateral plates. The intermediate region is characterized by a marked indentation on the posteroventral edge. Immediately below the intermediate region is the sclerite of the salivary duct. This sclerite is somewhat shoehorn-shaped, with a slight, posteriorly directed ventral extension. The basal region of the mouth hook consists of an upper and a lower wing. Early in the first stage the upper wing is slightly curved. As growth continues this region increases considerably in both length and width and shows a gradation in pigmentation, being darker nearer the lower wing (Fig. 6). Very little variation in size of the lower wing is observed during this stage of development.

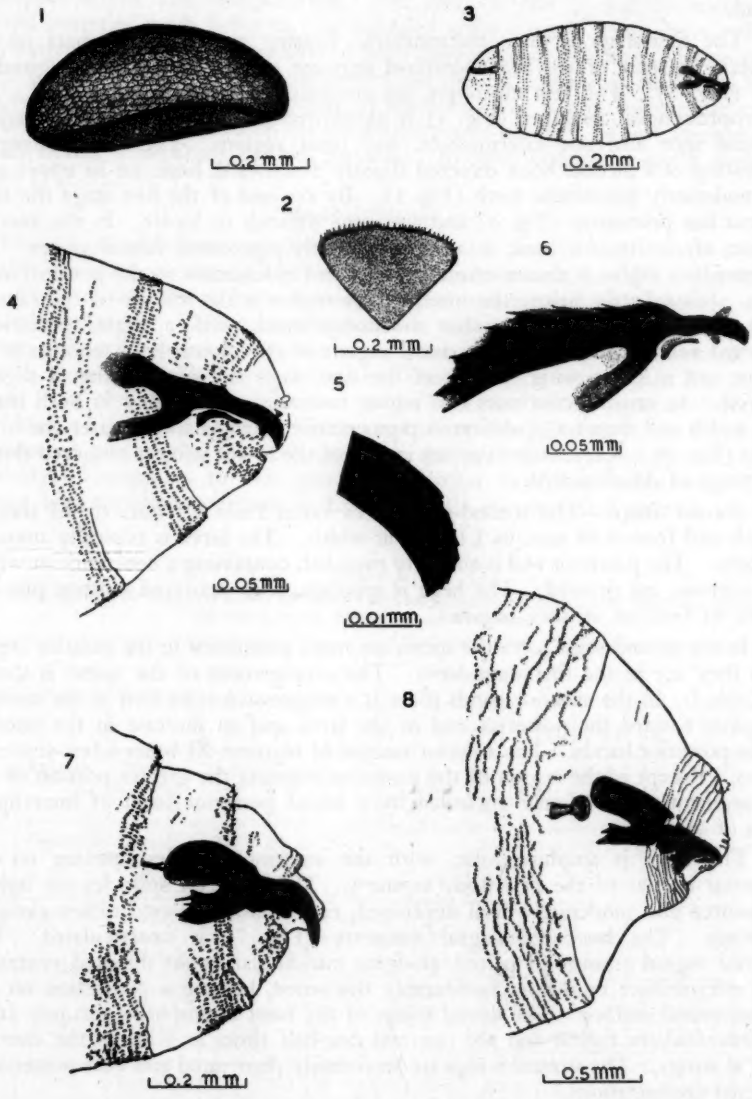
Second Stage.—The second-stage larva varies from 2.1 mm. to 3.5 mm. in length and from 0.84 mm. to 1.1 mm. in width. The larva is typically muscoid in form. The posterior end is abruptly rounded, containing a concavity in which the stigmata are situated. The head is spineless, with scattered sensory pits and a pair of bulbous sensory organs.

In the second-stage larva the spines are more prominent in the anterior region than they are in the first-stage larva. The arrangement of the spines is shown in Table I. In the anterior bands there is a progressive reduction in the number of spines toward the posterior end of the larva and an increase in the number in the posterior bands. The anterior margin of segment XI bears a few scattered spines. Except in the region of the posterior stigmata the greater portion of the last segment is completely encircled by a broad posterior band of interrupted rows of spines.

The larva is amphipneustic, with the anterior spiracles opening on the posterior border of the first body segment. The posterior spiracles are lightly pigmented and moderately well developed, each containing two rather elongate openings. The buccopharyngeal armature (Fig. 7) is unarticulated. The anterior region consists of paired, elongate mandibular hooks directed ventrally. The intermediate region is considerably thickened, bearing a projection on the anteroventral surface. The dorsal wings of the basal region arise abruptly from the intermediate region and are one and one-half times as wide as the shorter, ventral wings. The ventral wings are less heavily pigmented and bear posteriorly directed prolongations.

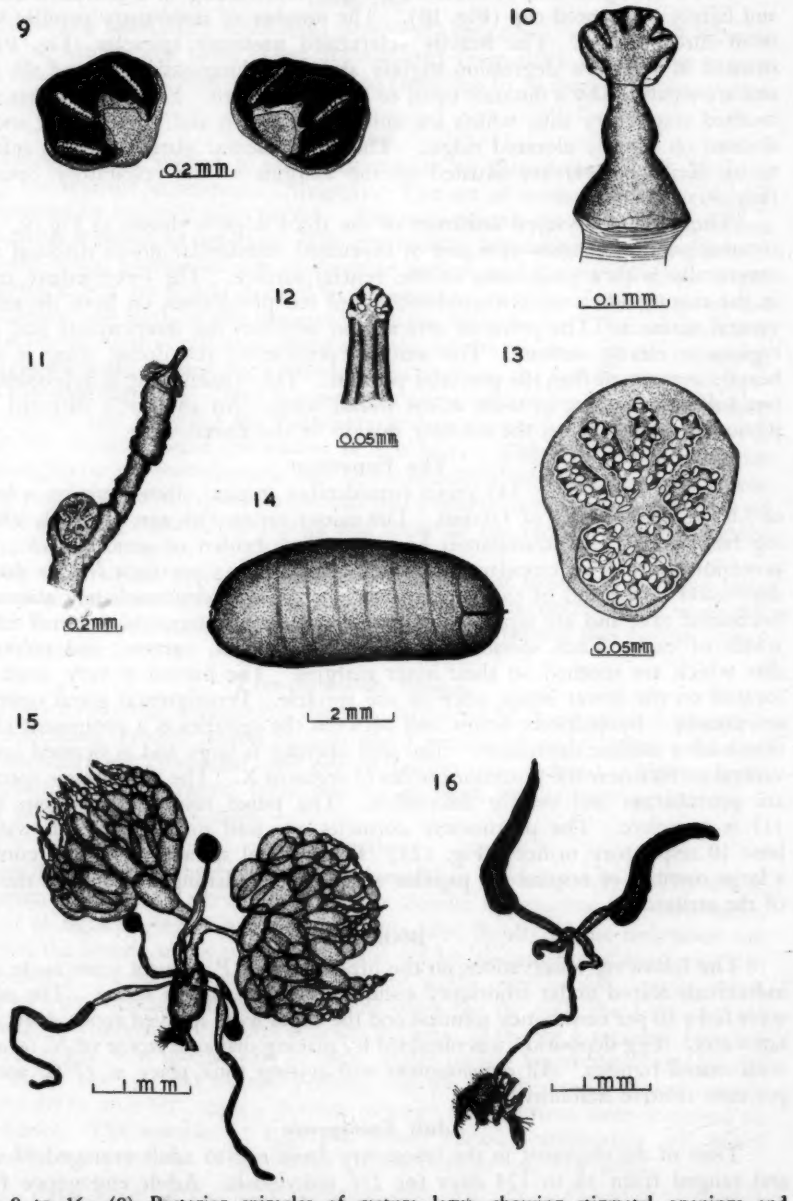
Third Stage.—The larvae feed voraciously during this stage, often attaining a length of 9 mm. and a width of 3 mm. The head is usually retracted into the first body segment and bears the antennary and preantennary organs described by Thompson (1928) (Fig. 8). A small patch of posteriorly directed spines is located directly below the buccal cavity. The spines on the remainder of the body (Table I) are unpigmented and difficult to locate. As in the earlier stages

the spines are more concentrated on the anterior portions of segments I to III. Segment XI is completely covered with scattered rows of spines both parallel and at right angles to the longitudinal axis of the larva. The area immediately sur-



FIGS. 1 to 8.—(1) Egg, dorsolateral view. (2) Egg, cross-section showing spines on dorsal surface. (3) First-stage larva, showing arrangement of spine rows and position of posterior spiracles. (4) First-stage larva at time of hatching, showing buccopharyngeal armature and spinal pattern of first two segments. (5) Tip of first-stage mouth hook. (6) Buccopharyngeal armature of late first-stage larva. (7) Second-stage larva showing buccopharyngeal armature and spinal patterns of first two segments. (8) Buccopharyngeal armature of third stage, showing point of articulation.

rounding the posterior stigmatal openings is free of spines. A circular patch of spines occurs between and slightly below the spiracular plates.



FIGS. 9 to 16.—(9) Posterior spiracles of mature larva, showing stigmatal openings and peristigmatal gland openings. (10) Anterior spiracle of mature larva, showing atrium, finger-like papillae, and hood. (11) Pupal respiratory apparatus removed from puparium. (12) Tip of prothoracic cornicle. (13) Internal spiracle. (14) Puparium. (15) Reproductive system of gravid female. (16) Reproductive system of male.

The larva is amphipneustic, bearing conspicuous anterior spiracles projecting from the posterior border of the first segment (Fig. 8). The atrium of the felt chamber is elongate and cylindrical, its apex terminating in a rounded, conical, and lightly pigmented cap (Fig. 10). The number of respiratory papillae varies from three to five. The heavily sclerotized posterior spiracles (Fig. 9) are situated in a shallow depression slightly above the longitudinal axis of the larva and are separated by a distance equal to half their width. Each spiracle has three toothed respiratory slits, which are uniform in length and arrangement and are situated on slightly elevated ridges. The perispiracular gland openings referred to by Keilin (1944) are situated on the margins of the respiratory openings (Fig. 9).

The buccopharyngeal armature of the third stage is shown in Fig. 8. The anterior portion consists of a pair of shortened mandibular hooks directed anteroventrally with a projection on the ventral surface. The intermediate region in the mature larva varies considerably and has projections on both dorsal and ventral surfaces. The point of articulation between the intermediate and basal regions is clearly defined. The anterior portion of the dorsal wing is more heavily pigmented than the posterior portion. The ventral wing is approximately one-half to one-third as wide as the dorsal wing. An anteriorly directed projection is noticeable on the anterior margin of the dorsal wing.

The Puparium

The puparium (Fig. 14) varies considerably in size, often attaining a length of 7.0 mm. and a width of 3.0 mm. The colour varies with age, gradually changing from a light, semitransparent brown to dark brown or almost black. The posterior spiracles are circular and shining black. They protrude from a shallow depression in the end of the puparial case, being located immediately above the horizontal axis, and are separated at their bases by a distance of one-half of the width of each. Each spiracle contains three straight, narrow, and colourless slits which are toothed on their inner margins. The button is very small and located on the lower inside edge of the spiracle. Peristigmatal gland openings are present. Immediately below and between the spiracles is a prominent elevation with a median depression. The anal opening is large and is situated on the ventral surface near the posterior border of segment X. The prothoracic spiracles are protuberant and readily discernible. The pupal respiratory system (Fig. 11) is complete. The prothoracic cornicles are well developed, each with at least 10 respiratory orifices (Fig. 12). The internal spiracle (Fig. 13) contains a large number of respiratory papillae arranged in radiating branches at the end of the atrium.

BIOLOGY

The following observations on the life-history of *P. hamata* were made with individuals reared under laboratory conditions except where noted. The adults were fed a 10 per cent honey solution and the cages were sprayed twice daily with tap water. Egg deposition was obtained by placing diapause larvae of *N. lecontei* with mated females. All development and rearing took place at 23°C. and 60 per cent relative humidity.

Adult Emergence

Time of development in the laboratory from egg to adult averaged 37 days and ranged from 18 to 124 days for 215 individuals. Adult emergence from puparia was high, with 92 per cent being recorded from 208 puparia. In a laboratory study of 200 specimens, three days elapsed between the height of emergence of the males and that of the females. Following the first peaks of emergence another peak was reached for both males and females at approximately

37 days after egg deposition. The sex ratio was almost constant at 56 per cent females. Newly emerged females appear to be much more active than males.

Longevity

Under the laboratory conditions previously described, adults of *P. hamata* live for a considerable time. Data accumulated from daily oviposition experiments showed that the length of life varied from one to 76 days, with an average of 34 days.

Mating

Mating in this species is somewhat similar to that described by Webber (1932) for *Sturmia inconspicua* (Meigen). The act of mating is not necessarily accompanied by any courtship period. The male mounts the female from behind and is rather difficult to dislodge. The prothoracic legs usually rest on the head or on the tergal portion of the prothoracic region, and the tarsal claws of the mesothoracic legs are firmly hooked to the anterior margins of the wings of the female about one-sixth of the distance from the wing bases. The metathoracic legs rest on the floor of the cage or the abdomen of the female. At the beginning of coition there are momentary adjustments in position, the female often attempting to dislodge the male. This is sometimes accomplished by the female raising her abdomen and bringing the metathoracic legs forward and then backward, forcing the wings toward the centre of the body. The hold on the anterior wing margins by the mesothoracic legs of the male is often broken by this action. Mating pairs soon settle down, however, and remain quiescent, the antennae of the male pointing toward the female and those of the female pointing slightly forward at a 45° angle.

The flies remain in coitus for varying lengths of time. Some have been observed to separate after 15 or 20 minutes whereas others have remained together for a period exceeding 16 hours. Ordinarily mating flies remain united about 3½ hours.

Preoviposition Period

In order to obtain oviposition, diapause larvae of *N. lecontei* were placed in cages containing freshly mated females for a period of eight hours each day. This procedure was continued until egg deposition was observed. Although the preoviposition period varied from one to 40 days, the average period for a sample of 30 flies was 6.5 days.

Oviposition

Egg deposition has been repeatedly observed in the laboratory. The act of oviposition takes place very rapidly. The female approaches the host larva, facing it at right angles to its length. Many false thrusts of the ovipositor are made and the female seems to be frightened off by movements of the larva. In some cases, if the larva is stationary, the fly walks over it, and, resting for a second or two, deposits an egg. In other cases the fly rolls the larva toward itself with its prothoracic legs and deposits the egg. The egg is securely fastened in a fold in the host integument at right angles to the longitudinal axis of the larva. After the egg has been deposited, the fly usually walks directly away from the larva at a 90° angle. Active oviposition continues over a period of three weeks. The number of eggs per female varied considerably, 393 being recorded as a maximum. The average for 31 females was 47.5 eggs.

Hatching of Egg and Development of Immature Stages

Examination of the egg 24 hours after deposition does not show any visible mouth hooks. It appears that this species deposits a true egg and that considerable embryonic development takes place within the chorion after

deposition. At the temperature of 23°C. and 60 per cent relative humidity the eggs take approximately 48 hours to incubate. The active first-stage larva emerges through the under-surface of the egg at the cephalic end and cuts its way through the host integument at this point. A respiratory funnel is formed below the entrance hole; the larva remains with the posterior spiracles in the funnel throughout the first, second, and part of the third instar. As the parasite larva feeds and increases in size, the funnel lengthens, becoming heavily sclerotized at its base, and less sclerotized and practically transparent at its distal end. Parasitized host larvae are readily discernible, since a large, brown, discoloured area is formed by the sclerotized respiratory funnel. The late third-stage larva leaves the funnel and moves about in the host, voraciously devouring the contents. Upon completion of feeding, the mature larva leaves the host, and forms its puparial case. Since diapause host larvae removed from the cocoons are used in laboratory propagation, the free larvae crawl to a darkened portion of the cage to form their puparial cases.

The time required for the development of the larval stages varied considerably. First-stage larvae were found in the greatest proportions in larvae which had been parasitized within a seven-day period. Second-stage larvae were observed most frequently in larvae which had been parasitized for seven to 12 days, and third-stage larvae in larvae parasitized 13 days or more. The time required from egg deposition to puparial formation varied from 14 to 20 days for 274 individuals, and under laboratory conditions an average of 36 per cent puparial formation was obtained. Dissections of superparasitized host larvae showed parasites in different stages of development. In laboratory experiments in which larvae were parasitized with several eggs each, never more than one parasite emerged from a single host. From dissections of field-collected cocoons it appears that *P. hamata* overwinters as a second-stage larva enclosed in the respiratory funnel formed in the host.

The Pupal Period

In the field the puparium is formed within the host cocoon, and the very effective provision made by the larva for escape of the adult was observed and previously reported by Baldwin and Coppel (1947). In the laboratory the larva forms its puparium on a paper mat in a rearing tray. The puparial case is completed within 24 hours after the mature larva leaves the host remains. The freshly formed puparial cases are very light in colour, becoming fully darkened within 24 hours. The duration of the puparial stage for 215 puparia averaged 18 days.

Host-Parasite Relationships

When a serious outbreak of *N. lecontei* was reported in 1943 from Actinolite, Ont., an investigation was initiated to determine the prevalence of parasites. The studies have been continued and have in every case shown the presence of the tachinid parasite *P. hamata*. A certain degree of competition from ichneumonid and chalcid parasites as well as from other dipterous species, such as *Spathimeigenia* sp., exists; but *P. hamata* was responsible for more than half the parasitism recorded for all species. In the study carried out in 1943 the total parasitism of *N. lecontei* amounted to 26 per cent, to which the tachinid parasites contributed 14.4 per cent, the ichneumonids 2.3 per cent and the chalcids 9.32 per cent. To the tachinid *P. hamata* alone 11.4 per cent was attributed, but the total, original parasitism caused by *P. hamata* was reduced by the chalcid parasite *Perilampus hyalinus*, which often acts as a hyperparasite of *P. hamata*.

Summary

Phorocera hamata A. & W. is a native parasite attacking several species of

sawfly larvae. It has been reared from *Neodiprion lecontei* Fitch, *N. nanulus* Schedl, and *N. banksianae* Rohw. in large numbers.

The parasite can be reared easily in the laboratory on sawfly larvae in diapause. The egg hatches in approximately 48 hours. The duration of the larval period is about 15 days and that of the pupal period approximately 18 days. Adults in confinement lived approximately 34 days. The parasites mate readily and the females require a preoviposition period averaging 6.5 days. The average number of eggs per female has been recorded at 47.5 although one female deposited 393 eggs. The egg, larval stages, and puparium are described in detail. In laboratory studies, never more than one parasite has reached maturity in a single host.

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On the Identity of *Agrilus anxius* Gory and Some Allied Species (Coleoptera: Buprestidae)*

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Agrilus anxius Gory has been reported as breeding in numerous species of birches and poplars. Because the species of *Agrilus* are often poorly characterized morphologically, and usually restrict their feeding to one or to a few closely allied species of plants, it has been suspected that two species were confused. Barter, working in New Brunswick, noted that male specimens reared from, or attracted to, birches and poplars were separable always by characters of their genitalia. He found also the differences in biology which are described below. Study of material in the Canadian National Collection and the U.S. National Museum shows that the genitalic characters hold in specimens associated with food-plants in other localities. Smith (1949, Nature 164:237), working with material reared in New Brunswick, found that males and females from birches have 22 chromosomes, and those from poplars only 20. Thus it has been demonstrated that two species, one feeding on birches, the other on poplars, have been confused as *Agrilus anxius*.

The following notes on taxonomy are intended only to supplement Fisher's excellent revision of the North American species of *Agrilus* (1928, U.S. Nat. Mus. Bull. 145), to which the reader is referred for additional bibliographic references and descriptive data. The species concerned fall in couplet 55 of Fisher's key, and they appear separable only by colour, food-plants, and characters of the male genitalia.

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As the location of the type specimen of *anxius* Gory is unknown, it is proposed here that the name *anxius* be conserved arbitrarily for the species feeding on birches, on account of the large amount of literature associated with that name and species. The species feeding on poplars is described below as *liragus* n. sp. *A. pensus* Horn is discussed because Fisher thought that it might be only a colour variety of *anxius* auct.; also considered are the doubtfully valid *horni* Kerremans and *gravis* LeConte and the synonym *torpidus* LeConte.

Key to Species

1. Above, dark coppery red, frequently with purple reflections. Male genitalia as in *populi* Fisher (1928, Bull. U.S. Nat. Mus. 145, Plate 4, Fig. 34) and *liragus* n. sp. Food-plants: *Alnus* and, probably, *Ostrya* ..... *pensus* Horn

   Above, blackish with olivaceous or plumbeous reflections; the head and pronotum sometimes, the elytra never, with coppery reflections 2

2. Lateral lobes of the male genitalia (Fig. 1, b) less narrowed apically and more bluntly pointed; ventrally, the bevel of the inner margin of each lobe much wider. Pronotum, and the vertex in the male or the entire head in the female, with brassy or coppery reflections that are sometimes lost in museum specimens. Food-plants: *Betula* spp. ..... *anxius* Gory

   Lateral lobes of the male genitalia (Fig. 1, a) more strongly narrowed and less bluntly pointed; ventrally, the bevel of the inner margin of each lobe narrower. Coppery reflections nearly always lacking and never distinct. Food-plants: *Populus* spp. ..... *liragus* n. sp.

Agrilus pensus Horn

Agrilus pensus Horn, 1891, Trans. Am. Ent. Soc. 10:305. Fisher, 1928, U.S. Nat. Mus. Bull. 145, p. 155.

This species can be differentiated from the other two only by colour and, in the case of *anxius*, by the male genitalia. It averages smaller and is less variable in size than the others, the males measuring 6.0 to 7.4 mm., the females 6.3 to 8.8 mm. *A. pensus* and *A. populi* Fisher are inseparable by genitalia and approach one another in colour. In *populi*, however, there are three small patches of condensed pubescence on each elytron, and in the male the claws of the middle tarsi are similar to one another and to those of the anterior tarsi. In *pensus*, pubescent spots are lacking, and the claws of the middle tarsi are dissimilar in the male, the outer being cleft like those of the anterior, the inner like those of the posterior tarsi.

Adults of *pensus* have been reported on the foliage of the alder *Alnus rugosa* (Du Roi) Spreng. (*incana* of American authors) and on hornbeam, *Ostrya virginiana* (Mill.) Koch. On two occasions near Halifax, N.S., Brown found adults in large numbers on *Alnus crispa* var. *mollis* (Fern.) Fern. We suspect that *pensus* depends largely on this alder and that this explains the distribution of the beetle. *A. pensus*, described originally from Massachusetts, is listed by Fisher from localities in Pennsylvania and New Jersey north to New Brunswick and Nova Scotia. Additional localities, represented in the Canadian National Collection, are as follows—NOVA SCOTIA: Ingramport, Halifax; NEW BRUNSWICK: Boiestown, St. Stephen, Red Bank, Penobsquis; QUEBEC: Knowlton; ONTARIO: Sudbury; MANITOBA: Aweme.

Agrilus anxius Gory

Agrilus anxius Gory, 1841, Mon Bupr. Suppl., vol. 4, p. 226, pl. 37, fig. 217. Fisher, 1928, U.S. Nat. Mus. Bull. 145, p. 160 (in part), pl. 4, fig. 35.

Agrilus torpidus LeConte, 1859, Trans. Am. Philos. Soc. 11:247. Fisher, 1928, U.S. Nat. Mus. Bull. 145, p. 162.

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(?) *Agrilus gravis* LeConte, 1859, Trans. Am. Philos. Soc. 11:247. Fisher, 1928, U.S. Nat. Mus. Bull. 145, p. 162.

(?) *Agrilus horni* Kerremans, 1900, Ann. Soc. Ent. Belgique 44:341 (=*Agrilus blanchardi* Horn, 1891, Trans. Am. Ent. Soc. 18:305, not Saunders, 1871). Fisher, 1928, U.S. Nat. Mus. Bull. 145, p. 158.

Fisher's figures of genitalia permit the separation of *anxius* from the other species considered here, as he figures *anxius* (Plate 4, Fig. 35) and also *populi* (Plate 4, Fig. 34) which will serve for *pensus* and *liragus*. *A. anxius* varies greatly in size, the males measuring from 6.5 to 9.8 mm., the females from 7.7 to 11.3 mm.

The present location of the type of *anxius* is unknown. The only specimens identifiable as types of *torpidus* and *gravis* are the two that bear the name-labels in the LeConte collection. The type of *torpidus* is a male, with genitalia extruded, labelled to indicate that it came from Lake Superior; that of *gravis*, also from Lake Superior, is a female lacking coppery reflections and therefore of doubtful identity. The type of *horni* remaining in the Horn collection is a male from Tyngsboro, Mass. It is unknown to us. Fisher was able to distinguish it only by the sexual characters of the abdomen, which are variable, and he notes that its occiput and pronotum are coppery. For these reasons, we suspect that it is referable to *anxius*.

A. anxius occurs from Newfoundland to British Columbia, and south to New Jersey, Ohio, and Colorado. We have seen specimens, reared or with genitalia extruded, from the following localities—NEWFOUNDLAND: Deer Lake; NEW BRUNSWICK: Fredericton (reared from *Betula lutea* Michx., *B. papyrifera* Marsh., and *B. populifolia* Marsh.), Tabusintac; QUEBEC: Aylmer (reared from *Betula*), Laniel (reared from *B. papyrifera*); ONTARIO: Ottawa (reared from *Betula*), Bobcaygeon, Simcoe; MANITOBA: Aweme, Onah (on *B. papyrifera*); BRITISH COLUMBIA: Creston (in pupal cell in *B. papyrifera occidentalis* (Hooker) Sarg.), Vernon (*Betula*); MASSACHUSETTS: Melrose (reared from *Betula*); CONNECTICUT: Lyme (reared from *B. lenta* L.); NEW YORK: Buffalo (in *Betula*); PENNSYLVANIA: Chestnut Hill (reared from *Betula*); NEW JERSEY: East Orange; OHIO: Cleveland; MICHIGAN: Detroit (destroying silver birch); MINNESOTA: Cass Co. (reared from *B. papyrifera*); SOUTH DAKOTA: Elmore (*Betula*); COLORADO: Waldo Canyon, Manitou (reared from *B. fontinalis* Sarg.), El Paso Co. (reared from *B. p. occidentalis*); IDAHO: Sand Point (on birch).

Agrilus liragus n. sp.

Agrilus anxius, of authors (in part). Fisher, 1928, U.S. Nat. Mus. Bull. 145, p. 160 (in part).
Agrilus torpidus, of authors (in part).
Agrilus gravis, of authors (in part).

Separable by colour, male genitalia, and food-plants as noted in the key above; otherwise as in *pensus* and *anxius*. Length of males, 7.2 to 10.3 mm., of females, 6.8 to 11.5 mm.; the average size greater than in *anxius*.

Blackish, with olivaceous or plumbeous reflections; the head greenish in the male except on the occiput; coppery reflections nearly always lacking but evident rarely near the lateral margins of the pronotum. Vestiture not condensed into patches on any part; not dense on the front or prosternum in the male, or on the vertical parts of the abdominal segments.

Antennal serrations beginning on the fourth segment. Pronotum with a distinct prehumeral carina on each side. Scutellum strongly, transversely carinate. Elytra vaguely costate; their apices not unusually prolonged, variable but usually less broadly rounded than in *anxius*. Pygidium with a projecting carina. First and second abdominal segments concave on the median line in the male; the concavities somewhat variable; that of the first segment with the sides and usually the bottom roughly punctate; that of the second narrower, impunctate, in the form of a deep groove ending near the apical fourth of the segment. Teeth of the tarsal claws not turned inward; all claws similar in the female; the males with the outer claw of each middle tarsus and the anterior claws similarly cleft but differing from the other claws, which are similar to one another.

Holotype ♂, *allotype* ♀, 25 ♂ and 24 ♀ *paratypes*: Fredericton, N.B., July, 1946 and 1947, reared from *Populus tremuloides* Michx. (G. W. Barter); No. 5803 in the Canadian National Collection, Ottawa.

A. liragus is known from New Brunswick to British Columbia and south to Pennsylvania and Arizona. We have seen specimens, reared or with genitalia extruded, from the following localities—NEW BRUNSWICK: Fredericton (reared from *Populus tremuloides* Michx., *P. grandidentata* Michx., and *P. balsamifera* L.); QUEBEC: Fort Coulonge (*Populus*), Laniel (reared from *Populus*); MANITOBA: Aweme (on *P. tremuloides*), Husavick; SASKATCHEWAN: Indian Head (*P. tremuloides*); ALBERTA: Waterton; BRITISH COLUMBIA: Creston (*P. tremuloides*), Vernon (*P. trichocarpa* Torr. and Gray); PENNSYLVANIA: Milford (*P. tremuloides*); MICHIGAN: Ann Arbor (in *P. tremuloides*); MINNESOTA: Itasca Park (on aspen), Cass Co. (reared from *P. tremuloides*); NORTH DAKOTA: Valley City (reared from cottonwood); COLORADO: Manitou (reared from *P. tremuloides*), El Paso Co. (reared from *P. tremuloides*), Colorado Springs (*P. deltoides* Marsh.); UTAH: Kamas (reared from *P. tremuloides*); ARIZONA: Bright Angle Range Sta. (aspen); OREGON: Austin (*P. tremuloides*).

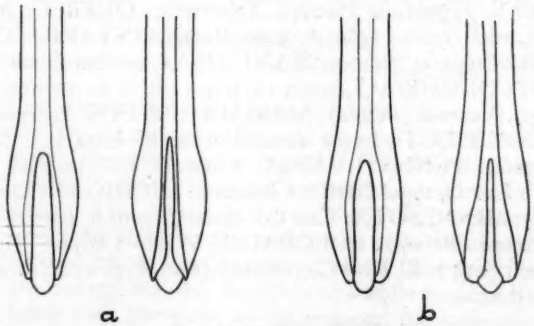

FIG. 1. Dorsal and ventral aspects of apices of male genitalia of: a, *Agrilus liragus* n. sp.; b, *A. anxius* Gory.

Biological Considerations

While studying *Agrilus anxius* and *A. liragus* in New Brunswick, Barter noted differences in the form of the larval galleries and in the period of adult activity, and made some observations on host selection and inter-specific copulation. The food-plants concerned in the following notes were white birch, *Betula papyrifera* Marsh., and the aspen *Populus tremuloides* Michx.

In birch the larval galleries were typically zigzag or winding throughout their length. In aspen the earlier instars, often all but the last, tended to form galleries that were compact, the sections lying close and parallel to one another as figured by Anderson (1944, J. Econ. Ent. 37(5):591, Fig. 2). Galleries were particularly compact in the more thrifty aspen and were less so in the dying and felled trees. Compactness in aspen appeared to be associated with the vigour of the cambium. Though galleries approaching the birch type were sometimes found in aspen, the compact type was not found in birch, although many observations were made on trees and logs. The same differences were noted in Minnesota by Anderson (loc. cit., p. 592), who wrote: "In birch the larvae usually formed winding galleries, whereas both winding and zigzag galleries were formed in aspen. The latter type was often very compact in trees that were not

damaged too severely; *i.e.*, those that were suppressed, girdled, or topped, but was much less frequent in the felled trees."

Emergence records from caged logs, involving several seasons and more than 2000 adults, showed that *liragus* began emerging from 6 to 16 days earlier than *anxius*; the period of emergence of *liragus* was shorter. The mean dates of emergence were from 8 to 20 days, with an average of 12.7 days, earlier for *liragus*. Observations in the field showed that *liragus* was attracted to logs from 10 to 14 days earlier than was *anxius*, and the period of adult activity of *liragus* ended 8 to 19 days, average 12 days, earlier.

Host selection by females that had been reared and mated was tested in cages. Twenty-five cages were supplied with both birch and aspen logs and with females of *anxius*. Oviposition, as shown by the development of galleries, occurred in 19 cages: on birch only in 14 cages, on aspen only in 3, and on both hosts in 2. Although the heaviest attack, 21 galleries, occurred on a birch log, 18 galleries developed in an aspen log. When 26 cages were supplied with both hosts and with females of *liragus*, galleries were formed in 16 cages: in aspen only in 15 cages, whereas one cage showed 15 galleries in aspen and 3 in birch. When 24 cages were supplied with aspen and females of *anxius*, galleries developed in 3 cages only. No galleries were formed in 24 cages with birch logs and females of *liragus*. Thus both species, especially *liragus*, showed strong tendencies to select in cages the hosts from which they were reared. Under natural conditions, selection was more strict; only one species was reared from or found on each host.

No evidence of interspecific copulation was found in the field. In the laboratory, such copulation occurred but was less frequent than intraspecific matings.

Notes on Some Nearctopsyllinae, with Descriptions of Two New Species of *Nearctopsylla* from California (Siphonaptera)[1]

By G. P. Holland[2] and E. W. Jameson, Jr.[3]

The genera *Nearctopsylla* Rothschild 1915, *Corypsylla* Fox 1908, and *Corypsylloides* Hubbard 1940, all apparently strictly Nearctic, comprise a natural group which is intimately associated with certain mammals of the Order Insectivora. A subfamily, Nearctopsyllinae, of the Hystrichopsyllidae, has recently been proposed (Holland, 1949:102) to accommodate these three genera, which are well separated from other fleas on the basis of a number of well marked morphological characteristics.

Corypsylla is associated with the Talpidae, the genotype, *C. ornata* Fox, occurring on moles of the genus *Scapanus*, whereas *C. jordani* Hubbard appears to be equally confined to the shrew mole, *Neurotrichus*. Although these species are ecologically isolated by reason of their special host requirements, they are sympatric, much of their geographical ranges coinciding. A third species, *C. setosifrons* Stewart, from California, is in some doubt. *Corypsylla* is known only from extreme western North America, from British Columbia southwards to California.

Corypsylloides is monotypic. The genotype, *C. kohlsi* (Hubbard) (=*C. spinata* Fox), is a true parasite of long-tailed shrews, *Sorex* spp., from southwestern British Columbia to California.

Nearctopsylla is primarily a western genus, most of the known species being restricted to regions west of the Rocky Mountains; there is one species at least which extends to the Atlantic States. Four species, one of which is represented

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by two or three subspecies, have been described. Two further species are described in the present paper.

Though many of the records of *Nearctopsylla* spp. have been from weasels or other mustelids, the true hosts are apparently moles or shrews; the other records are explainable by predation. However, up to the present, *all* available records of the genotype, *N. brooksi* (Roths.), have been from *Mustela* or *Martes*. This species, which is much larger and darker than the others, may be a true parasite of Mustelidae. Undoubtedly, further collecting and study will reveal its true host.

Of the others, *N. hyrtaci* (Roths.) is known only from British Columbia and Montana, where the true hosts are shrews, *Sorex* spp.

N. jordani Hubbard, from southwestern British Columbia to California, occurs on moles, *Scapanus* and *Neurotrichus*.

N. genalis (Baker) was described from a single male collected at Lansing, Mich., on *Scalopus*, a mole. Fox (1940:91) has synonymized *N. hygini* (Roths.) (from Red Deer, Alta., on the weasel "*Putorius richardsoni*") with *genalis*, an action justification of which is questionable (Holland, 1949:105-106). Until adequate topotypical material is available for study, it appears best to recognize *hygini* Rothschild and *laurentina* Jordan and Rothschild (described as a subspecies of *hygini*) as subspecies of *genalis*. *N. g. laurentina* is known from Ontario, New Brunswick, and Labrador in Canada, and from New York, Massachusetts, Maine, and Vermont in the United States. It has been collected from shrews of the genera *Sorex and Blarina* and, in addition, from weasels and a few other secondary hosts.

Recently, two new species of *Nearctopsylla* have been discovered in California. Descriptions of these follow:—

Nearctopsylla hamata n. sp.

Male

Chaetotaxy of head as shown in Fig. 1.

Pronotal ctenidium of 21-22 spines per side. Metanotum without pseudosetae under the collar. Abdominal terga I, III, and IV with one apical spinelet per side; tergum II with two, sometimes one. Single antepygidial seta, which is slender and relatively short, being no longer than the pygidium. Anal tergum armed with about three stout, curved setae per side.

Clasper lobe broad, with about 12 short spiniform setae on the inner surface, located in a group near the acetabulum. Dorsal margin of clasper armed with a sparse scattering of setae except at the posterior apex, where there is a group of about six or seven which are long and somewhat curved (Fig. 2). Movable process long and narrow (5 x 1) and articulated low down on clasper. It extends dorsally to the apex of the immovable process. Sternum IX with ventral arm sharply angulate, turning dorsally, and bluntly rounded apically. At the angle are about three stout setae, and along the posterior margin, from the apex down, a concentrated "brush" of about 12. Penis rods not completing a turn.

Female

Pronotal ctenidium of 14-15 spines per side. Abdominal terga with spinelets as follows: I, 1; II, 2-4; III, 2; IV, 1-2 per side (in the limited material available). Antepygidial setae two per side, of which the dorsal is a trifle longer than the ventral.

Receptaculum seminis with the sides of the head subparallel, not globular. The tail is long and straight, and has a sharp bend apically (Fig. 3).

Tergum VIII has about six thickish setae located at the posterior apex on the inner surface, two long setae near the margin below these, and an irregular

vertical row of about five long setae laterally. Sternum VII has two long setae, close together, high on the lateral surface, and 3 or 4 on each side ventrally. The apical margin of sternum VII on each side has a bluntly pointed lobe and a broad shallow sinus.

Holotype male and allotype female from Quincy, Plumas Co., Calif., December 28, 1948, collected from the shrew mole, *Neurotrichus gibbsii* (Baird), by E. W. Jameson, Jr., deposited in the United States National Museum, Washington, D.C. Paratype male and female, also from Quincy, Calif., November 2, 1948, collected from California mole, *Scapanus latimanus* (Bachman), deposited in the Canadian National Collection, Ottawa, Ont.

The species is very distinct, and shows no very close affinities with any other described form. The angulate sternum IX of the male suggests a kinship with *N. brooksi*, the only other species with this character, but a comparison of other structures demonstrates the superficiality of this resemblance. Actually, the species is perhaps closest to *N. jordani*, but again, amply removed. As the present small series is from two genera of moles, the true host relationships of this flea cannot be stated at this time.

***Nearctopsylla princei* n. sp.**

Nearest *N. hyrtaci* (Roths.), with which it agrees in most respects, differing principally in the genitalia.

Male

Head capsule more broadly rounded and with the frontal setae somewhat shorter than in the preceding species. Third genal spine relatively short (Fig. 4).

Pronotal ctenidium of about 12 (11-14) spines per side. No pseudosetae on metanotum. Abdominal spinelets: I, average 1.55 (1-3) per side; II, 2.15 (1-3); III, 1.42 (1-2); IV, 1.17 (1-2).

Single antepygidial seta, proportionately longer than in *hamata*. Setae on anal tergum not curved and thickened as in *hamata*.

Clasper lobe broad, with a few small setae disposed marginally as shown (Fig. 5). Patch of short setae on inner surface less extensively developed than in *hyrtaci* (cf. Figs. 5 and 6). Movable process somewhat smaller than in *hyrtaci* although of much the same shape, and inserted somewhat higher on the clasper, at about the mid point, near the posterior margin. Ventral arm of sternum IX very characteristic, being much broader than in any other known species, curving dorsally somewhat as in *hyrtaci*, but not cut off abruptly apically as in that species, and with the ventral margin and apical setae shorter and less numerous (cf. Figs.). The row of small setae outlining the depth of incrassation along the dorsal margin situated much farther down from the margin than in *hyrtaci*. Penis rods not completing a turn.

Female

Pronotal ctenidium of about 12 (11-13) spines per side, as in the male. The species is unusual in this respect, in that most members of the genus have the males with a greater number of pronotal spines (including *hyrtaci*, of which the males average 16-17 spines per side, and the females 13-14). Abdominal spinelets averaging (20 specimens): I, 1.52 (1-3); II, 2.35 (1-3); III, 1.70 (1-2); IV, 1.05 (1-2); V, .075 (0-1).

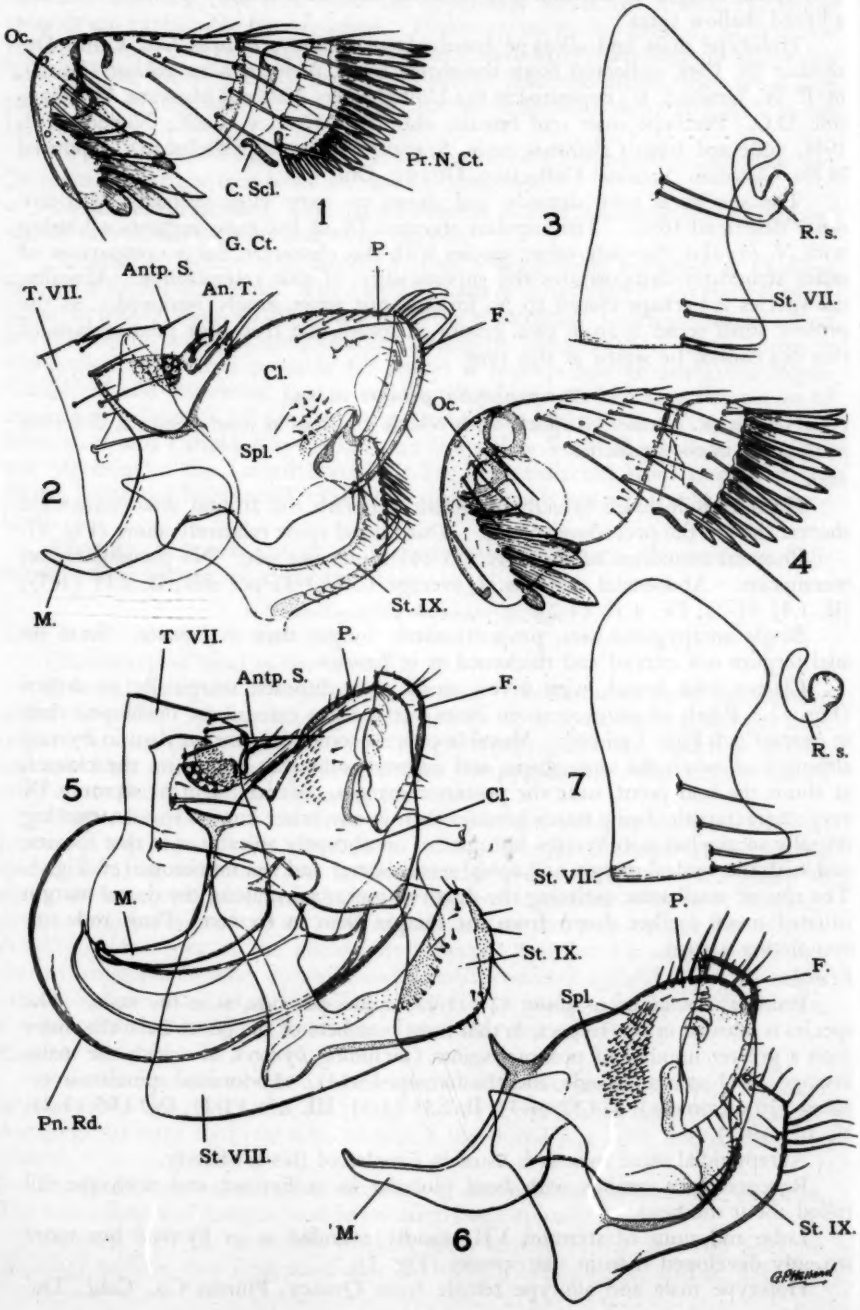
Antepygidial setae two, as is usual in females of this subfamily.

Receptaculum seminis with head globular as in *hyrtaci*, and with the tail rolled about the head.

Lobe and sinus of sternum VII broadly rounded as in *hyrtaci*, but more strongly developed than in that species (Fig. 7).

Holotype male and allotype female from Quincy, Plumas Co., Calif., De-

cember 9, 1948, collected from Trowbridge's shrew, *Sorex trowbridgii* Baird, by E. W. Jameson, Jr., deposited in the United States National Museum.



Paratypes 21 males and 21 females, all from the same locality and host, on the following dates: October 31, November 14, 28, December 4, 8, 9, 11, 21, 28, and 30, 1948.

As with most species of the genus, *N. princei* appears to occur in the adult stage only during the fall and winter months. Concentrated collecting of *Sorex trowbridgii*, which is undoubtedly the true host, in the spring and summer at Quincy yielded no fleas of this species. The species is named after Frank M. Prince of the Plague Suppressive Measures Laboratory, San Francisco, Calif.

Keys to the Species of *Nearctopsylla*

Males

1. Pronotal comb of more than 20 spines per side. Posterior half of ventral arm of sternum IX bent dorsally at a sharp angle, and with a thick fringe of setae on its posterior margin ... 2
   Pronotal comb of fewer than 20 spines per side. Ventral arm of sternum IX not sharply bent, and with setae scattered ... 3
2. Metanotum with pseudosetae under collar. Caudal border of movable process strongly convex; cephalic border straight or slightly concave. Process with row of setae extending around the apex and on to the caudal border, increasing in size ventrad ... *brooksi* (Roths.)
   Metanotum without pseudosetae. Margin of movable process subparallel. Apex of process with a group of about six equal, curved setae ... *hamata* n. sp.
3. Apex of ventral arm of sternum IX blunt ... 4
   Apex of ventral arm of sternum IX pointed ... 5
4. Margins of ventral arm of sternum IX subparallel, and cut off obliquely at apex. Ventral setae curved and as long as width of sternum IX at apex ... *hyrtaci* (Roths.)
   Sternum IX with ventral margin strongly convex; marginal setae shorter than width of ventral arm of sternum IX ... *princei* n. sp.
5. Movable process slender, approximately 5 times as long as wide. Penis rods with less than one-half turn ... *jordani* Hubb.
   Movable process approximately three and one-half times as long as wide. Penis rods in one turn ... *genalis* (Bak.)

Females

1. Head of receptaculum seminis globular ... 2
   Head of receptaculum seminis not much broader than tail; not globular ... 4
2. Pronotal comb of 18-20 spines per side. Tail of receptaculum seminis about 3 times as long as head ... *brooksi* (Roths.)
   Pronotal comb of 12-14 spines per side. Tail about twice as long as head ... 3
3. Sinus of sternum VII broad and deep; its depth about half the distance between the lobes ... *princei* n. sp.
   Sinus of sternum VII shallow, its depth less than one-quarter the distance between lobes ... *hyrtaci* (Roths.)
4. Upper lobe of sternum VII acute ... *jordani* Hubb.
   Upper lobe bluntly pointed or broadly rounded ... 5
5. Upper lobe of sternum VII bluntly pointed. Apex of tail of receptaculum seminis sharply hooked ... *hamata* n. sp.
   Upper lobe broadly rounded. Tail of receptaculum seminis curved, not sharply bent at apex ... *genalis* (Bak.)

References

Fox, Irving. 1940. Fleas of Eastern United States. Iowa State College Press.
Holland, G. P. 1949. The Siphonaptera of Canada. *Canada Dept. Agr. Tech. Bull. 70.*

Explanation of Figures

FIG. 1. *Nearctopsylla hamata.* Head and pronotum of male. (holotype)
FIG. 2. *N. hamata.* Genitalia of male. (holotype)
FIG. 3. *N. hamata.* Receptaculum seminis and sternum VII of female. (allotype)
FIG. 4. *Nearctopsylla princei.* Head and pronotum of male. (holotype)
FIG. 5. *N. princei.* Genitalia of male. (holotype)
FIG. 6. *Nearctopsylla hyrtaci.* Genitalia of male. (Specimen from Blue River, B.C.)
FIG. 7. *N. princei.* Receptaculum seminis and sternum VII of female. (allotype)

Abbreviations

An.T., anal tergum; Antp.S., antepygidial seta; Cl., clasper lobe; C.Scl., cervical sclerite; F., movable process of clasper; G.Ct., genal ctenidium; M., manubrium; Oc., eye; P., immovable process; Pn.Rd., penis rod; Pr.N.Ct., pronotal ctenidium; R.s., receptaculum seminis; Spl., patch of spinelike setae on inner surface of clasper; St., abdominal sternum; T., abdominal tergum.

Two New Species of *Opius* from Rose Hips (Hymenoptera: Braconidae)

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In the course of studies on the insects of rose hips Dr. W. V. Balduf, of the University of Illinois, reared and sent me for identification two species of *Opius*, both parasites of *Rhagoletis alternata* (Fall.). These are distinct from all described American species, and so far as I have been able to determine, they are different from all species of *Opius* known in Europe, where the host also occurs. Accordingly, both are described here as new.

Opius rosicola, new species
(Fig. 1, A and D)

Runs to *canaliculatus* Gahan in Gahan's key[1] but may be distinguished from that species by the obsolescence of the dorsal keels of the first tergite at the apical third of the tergite, by the distinctly bulging temples, by the somewhat shorter clypeus, by having the propodeal areola more weakly margined and open anteriorly, and by the longer ovipositor.

Female.—Length about 3.2 mm. Stout. Head strongly transverse, smooth and polished; antennae usually 36- to 38-segmented; temples distinctly bulging a little beyond eyes; anterior margin of clypeus straight; a large, transverse opening between clypeus and mandibles; malar space shorter than basal width of mandible; clypeus more than four times as broad as its median length.

Thorax strongly convex, higher than broad; mesoscutum and scutellum smooth and polished; notaulices sharply impressed anteriorly, but entirely wanting on posterior two-thirds of mesoscutum; a long slit-like median impression on posterior half of mesoscutum; propodeum rugulose, with a short median keel at base that extends to the prominent, irregularly arched, transverse ridge; areola open; mesopleural impression broad and with eight or more foveae; wing venation as shown in Figure 1, A.

Abdomen strongly convex, not twice as long as broad; first tergite with the prominent dorsal keels converging to about the apical third where they are obsolescent; apical third of first tergite rugulose medially; second and following tergites smooth and polished; suturiform articulation sometimes faintly indicated at middle; ovipositor sheath about as long as hind tibia.

Ferruginous; antennal flagellum black; all tarsi with the apical segment blackish; mesosternum and propodeum sometimes a little infuscated; abdomen entirely reddish yellow; ovipositor sheath black; wings hyaline, stigma dark brown.

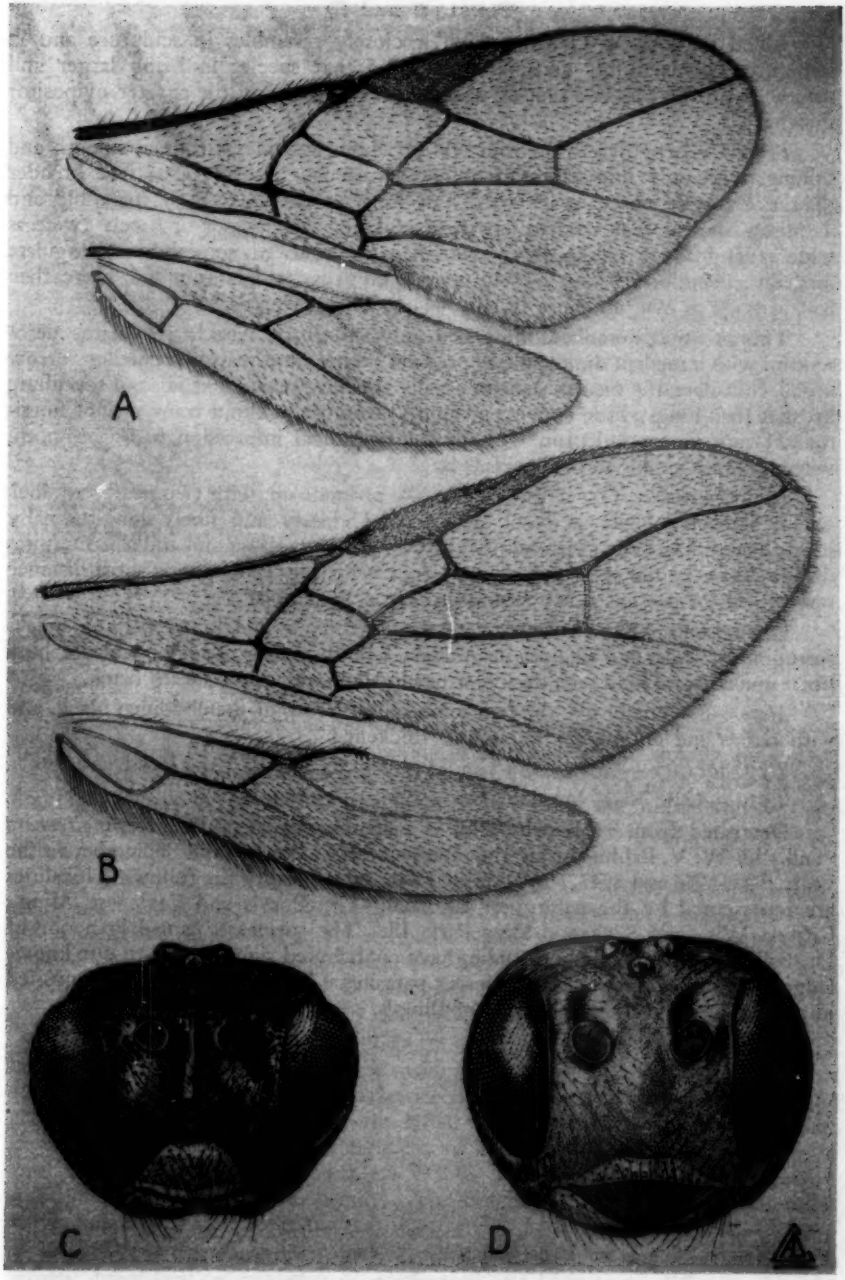
Male.—Essentially as in the female.

Type locality.—Eaglenest, Minn.

Type.—U.S. Natl. Mus. No. 59355.

Described from 49 females and 31 males reared from *Rhagoletis alternata* (Fall.) in rose hips, in July, August and September and in the years 1945 to 1947. In addition to the type locality the following localities are represented in the series of paratypes: Ely and Purvis, Minn.; Minnesota-U.S. Highway 61 at Temperance River, at Cascade River and at Pike Lake Road; Madison, Chetek, Solon Springs and Sarona, Wis.; and Kickapoo State Park, Ill. Paratypes in collection of University of Illinois.

[1]Proc. U.S. Natl. Mus. 49: 70, 1915.



New Species of Opius

Opius baldufi, new species
(Fig. 1, B and C)

Allied to *downesi* Gahan, which it closely resembles in sculpture and in structure; but it differs conspicuously from that species in being larger and stouter, with the thorax about as wide as the head, and in the shorter ovipositor sheath.

Female.—Length 3 to 3.5 mm. Head about as wide as thorax, smooth and shining, with only fine setigerous punctures on face and clypeus; face broader than eye height; malar space hardly as long as basal width of mandible and definitely shorter than median length of clypeus; clypeus not or barely twice as wide as long down middle, its anterior margin outbowed, sometimes subangulate medially; mandibles fitting closely against clypeus; temple rounded, more than half as wide as eye; antennae usually 44- to 47-segmented.

Thorax stout; notaulices impressed only anteriorly, weakly foveolate; mesoscutum with a median dimplelike impression before hind margin; scutellar furrow broad, foveolate, the median septum usually the most prominent; disc of scutullum broader than long, a little convex; propodeum rugose, without transverse or longitudinal carinae; mesopleuron without a longitudinal impression below, smooth; wing venation as shown in Figure 1, B.

Abdomen stout; first tergite rugose like propodeum, with two nearly parallel, widely-separated keels on basal half; second closely and finely longitudinally striate except narrowly at lateral margins; suture between second and third tergites distinct but very fine; striae of second tergite sometimes extending a short distance upon third; ovipositor sheath almost as long as hind tibia.

Ferruginous; head black, with clypeus, mandibles and lower part of cheeks ferruginous; scape and pedicel of antenna reddish yellow, flagellum black; hind tibiae apically and hind tarsi dusky; wings hyaline; ovipositor sheath black.

Male.—Essentially like the female but with the tip of the abdomen black, and with radius and cubitus conspicuously thickened.

Type locality.—"Minnesota-U.S. Highway 61 at Pike Lake Road."

Type.—U.S. Nat. Museum No. 59356.

Described from 13 females and 14 males reared from *Rhagoletis alternata* (Fall.) by W. V. Balduf during the months of July, August and September in the years 1945, 1946 and 1947. In addition to the type locality the following localities are represented by the paratypes: Ely, Bally Cr., Purvis and Eaglenest, Minn.; Chetek, Wis.; and Kickapoo State Park, Ill. The species is named in honor of Dr. Balduf whose painstaking studies have contributed significantly to our knowledge of the bionomics of certain insect parasites. Paratypes have been deposited in the collection of the University of Illinois.

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